UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WASHINGTON, D. C.
H. H. BENNETT, CHIEF

ADVANCE REPORT

on the

SEDIMENTATION SURVEY OF LANCASTER RESERVOIR

LANCASTER, SOUTH CAROLINA

June 15 to June 30, 1938

by

Mark P. Connaughton and Jack. L. Hough

Sedimentation Division
Office of Research
SCS-SS-36
September 1940

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South Carolina Agriculture Experiment Station
Clemson, S. C.
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ABSTRACT

The sedimentation survey of Lancaster Reservoir was made as part of a Nation-wide study of rates and causes of reservoir silting, especially as influenced by soil erosion and land use.

Lancaster Reservoir, the municipal water supply for Lancaster, S. C., is a 242-acre-foot, semibasin-type reservoir on Turkey Quarter Creek, a minor tributary of Bear and Cane Creeks which flow into the Catawba River. The 9.4-square-mile drainage basin of the reservoir lies near the outer edge of the Piedmont Upland and is characterized by gently rolling topography. The area is underlain by a complex assemblage of igneous, metamorphic, and sedimentary rock types, which have given rise to residual soils varying in texture from sands to clay loams. Moderate to severe sheet erosion and occasional gullying has occurred over the greater part of the drainage basin. At the present time about 70 percent of the land is cleared and only 30 percent wooded. It is estimated that approximately 60 percent of the area is now cultivated and 10 percent is open pasture. The principal crops are cotton, corn, and small grains, with the intensively cultivated crops greatly predominating.

The reservoir sediment ranges in texture from coarse sand to clay. Laboratory studies of the sediment showed median diameters of from 600 microns, near the head of deposition, to 2 microns near the dam. The volume weight of the sediment ranges from 33 to 79 pounds per cubic foot. Average sediment thicknesses remain constant at about 1.5 feet for 2,000 feet above the dam, attain a maximum of 3 feet in the well-defined delta 3,000 feet above the dam, then decrease to zero at 6,000 feet. A minor proportion of the lake sediment is contributed by wave erosion along the cleared lake shores, but by far the larger part represents stream-borne debris from eroding agricultural land.

The survey revealed that a total of 52 acre-feet (83,890 cubic yards) of sediment had accumulated in the reservoir at an average rate of 28.3 cubic feet annually per acre of drainage area, entailing an annual storage loss of 1.60 percent, or a total of 21.5 percent to the date of this survey.

The high rate of sedimentation indicated by the survey points to an urgent need for adoption of soil-conserving measures on the agricultural lands of the drainage area.

INTRODUCTION

This report is one of a series of advance reports on reservoir-silting investigations made by the Sedimentation Division of the Soil Conservation Service. Each reservoir survey is a part of a Nation-wide study of the condition of American reservoirs with respect to storage reduction by silting. The ultimate objective of these studies is to determine rates and causes of reservoir silting, in order to derive a practical index to (1) the useful-life expectancy of existing or contemplated reservoirs and (2) differences and changes in regional erosion conditions as influenced both by natural factors and by land use.

The sedimentation survey of Lancaster Reservoir was made during the period June 15 to June 30, 1938. The survey party consisted of Leland H. Barnes, chief of party, Mark P. Connaughton, party geologist, Alvin T. Talley, and Joseph Meisler. Studies of the lake sediment and an inspection of the drainage area were made by the writers.

Laboratory studies of the sediment samples were made under the direction of Jack L. Hough in the laboratory of the city filtration plant at High Point, N. C. Laboratory facilities were furnished through the courtesy of the city of High Point. Mechanical analyses of the sediment samples were made by Richard G. Grassy in the laboratory of the Sedimentation Division, Greenville, S. C.

The cooperation and assistance of the Lancaster city officials particularly of Mr. H. A. Montgomery, chief of police, greatly facilitated the sedimentation survey. The city furnished information on the history and cost of the reservoir, and supplied material for the construction of survey monuments. Mr. S. C. Mobley of the Lancaster filter plant furnished much valuable information on pre-reservoir conditions in the basin and on the observed progress of sedimentation within the basin.

Members of the staff of the Soil Conservation Service Demonstration Project SC-5 at Lancaster, particularly M. B. Brissie, project manager, were of material aid in the survey. The cooperation and assistance of A. F. Ruff and various members of the staff of the Catawba River Soil Conservation District SC-104 at Rock Hill, S. C. are gratefully acknowledged.

GENERAL INFORMATION

Location (fig. 1):

State: South Carolina.

County: Lancaster.

Distance and direction from nearest city: The dam is 1.7 miles southeast of the city of Lancaster.

Drainage and backwater: The reservoir is on Turkey Quarter Creek, 0.5 mile above its junction with Bear Creek. From the mouth of Turkey Quarter Creek, Bear Creek flows northwestward for 3 miles to join Cane Creek and Cane Creek flows thence southwestward 3 miles to the Catawba River.

Ownership: City of Lancaster.

Purpose served: Municipal water supply.

Description of dam (fig. 2):

The dam is an earth-fill, gravity-type structure with a clay corewall. It has an overall length of approximately 450 feet, a height of 26 feet above the deepest part of the original stream channel, and a crest width of approximately 8 feet. The downstream face of the dam has a 2:1 slope and the upstream face has a 1 1/2:1 slope. Exposed portions of the dam are protected by a fair cover of vegetation.

The concrete spillway, located on the northeast shore of the lake approximately 500 feet above the dam, cuts through the narrow divide separating Turkey Quarter Creek from a small unnamed stream which flows approximately parallel and enters Bear Creek above the junction of Turkey Quarter Creek. The small stream now carries all the overflow from the reservoir. The spillway has a crest width of 70 feet. The apron has a slope of 13° for 50 feet, and at its lower end discharges water over a rock outcrop to the plunge pool below. Concrete wing walls, varying in height from 4 to 7 feet, confine the overflow to the spillway apron. The present crest elevation of the spillway is 7 feet below the top of the dam and 19 feet above the

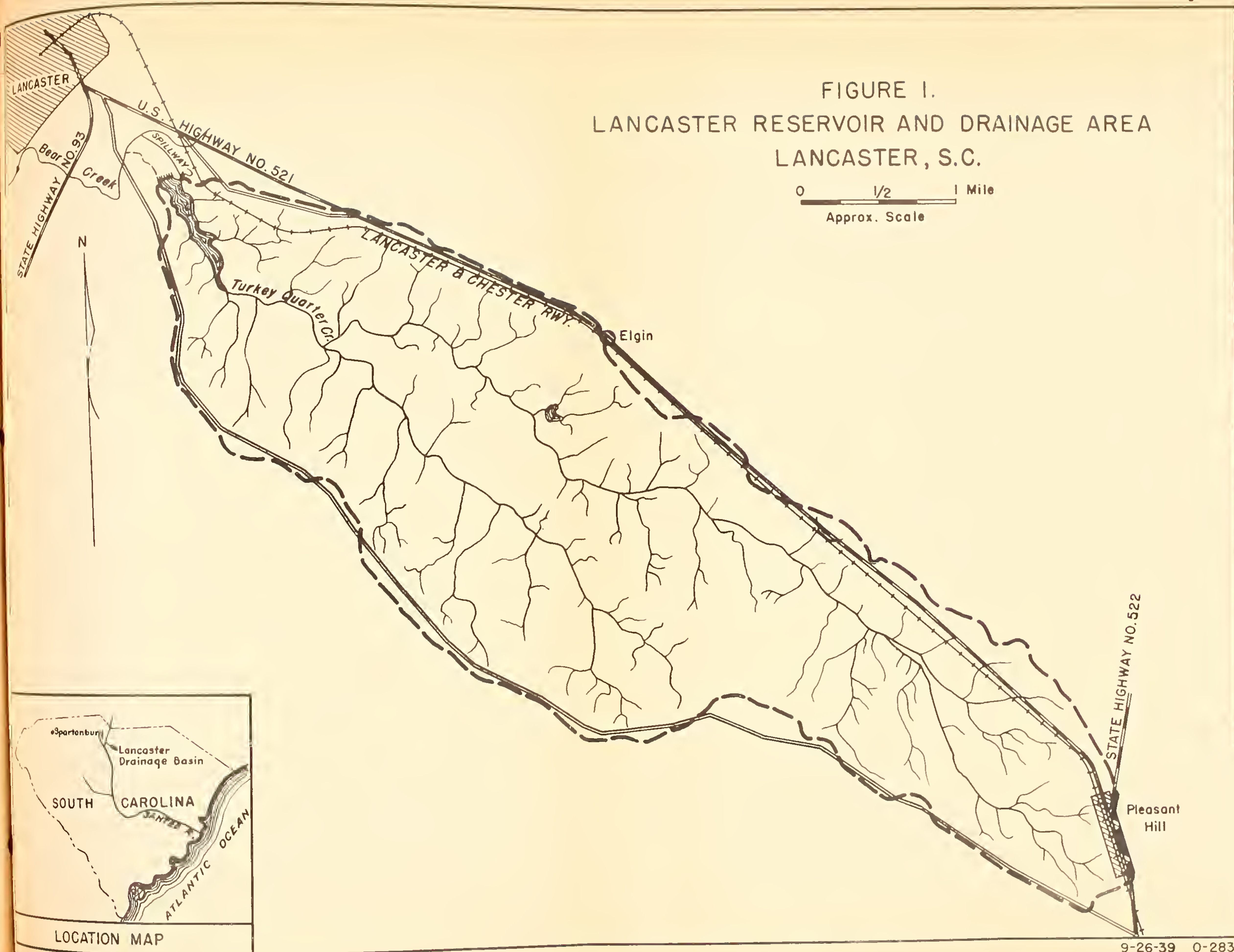
FIGURE I.
LANCASTER RESERVOIR AND DRAINAGE AREA
LANCASTER, S.C.
0
1/2
1 Mile
Approx. Scale
LANCASTER
U.S. HIGHWAY NO. 521
SPILLWAY
Bear Creek
STATE HIGHWAY NO. 93
N
LANCASTER & CHESTER RWY.
Turkey Quarter Cr.
Elgin
STATE HIGHWAY NO. 522
Pleasant Hill
Spartanburg
Lancaster Drainage Basin
SOUTH CAROLINA
SANTEE R.
ATLANTIC OCEAN
LOCATION MAP

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Figure 2.--View of Lancaster Dam and lower section of reservoir. Note spillway in middle background.

Figure 3.--View of delta of Lancaster Reservoir, looking downstream from 505. Note natural levees adjacent to main channel in immediate foreground.

deepest point in the original channel. The spillway crest was raised 18 inches in June 1931.

The single 12-inch intake pipe in the dam is located 4 feet below crest elevation. A blow-off valve is located near the bottom of the dam, but has never been used.

The total original cost of the reservoir, including property and construction, is listed as $10,000. This may be regarded as a minimum figure since it does not include the additional costs of spillway improvements.

Date of completion of dam: February 1925. At the time of the survey the lake was 13.4 years old.

Length of lake: 0.84 mile (4,450 feet) from the dam to the upper end of the basin proper, not including 0.42 mile (2,200 feet) of narrow ponded channel.

Area of lake at spillway stage:

Original	36.4 acres
At date of survey	35.1 acres
Reduction	1.3 acres

Storage capacity to spillway level:

	Acre-feet	
Original	242	(78,855,700 gals.)
At date of survey	190	(61,911,500 gals.)
Reduction	52	(16,944,200 gals.)

General character of reservoir basin.

The elongated, irregular outline of the reservoir basin is shown in figure 4 (following p. 18). Water is impounded on the flood plain of Turkey Quarter Creek to within about one-half mile of the head of backwater, and is confined to the original stream channel above

this point. Lake widths in the lower reaches vary irregularly from 160 to 650 feet, averaging 365 feet, from which they decrease abruptly to an average of about 25 feet in the ponded-channel section.

The valley of Turkey Quarter Creek in the lake reach is characteristically trough-shaped in cross section, having moderately sloping valley walls, and a wide, flat flood plain incised by a narrow, well-defined channel. Valley slopes range from 6 to 40 percent averaging about 18 percent. Flood-plain widths in the submerged section vary from 110 to 410 feet, averaging 240 feet. The original stream channel is incised about 7 feet below the level of the flood plain. In the lower portion of the reservoir, the flood-plain surface is submerged to an average depth of about 12 feet.

The original stream channel follows a fairly straight course through the basin. The average original gradient of the stream bed was 15.1 feet per mile from the head of backwater to the dam.

The gently sloping valley sides adjacent to the reservoir have been kept clear of vegetation throughout the life of the reservoir. Wide-spread wave erosion, although on a minor scale due to the short "fetch" of the lake in the direction of normal wind movement, has occurred along most of the shore line. The delta area is heavily overgrown with reeds, tules, and swamp grass.

<u>Area of drainage basin</u>: 9.4 square miles, or 6,016 acres, as determined by automobile reconnaissance of the watershed, using a Lancaster county road map on a scale of 1 mile to the inch as a base.

<u>General character of drainage basin</u>.

<u>Geology</u>.--The drainage area tributary to Lancaster Reservoir lies near the outer edge of the Piedmont Upland section of the Piedmont Plateau province. In general three major geologic subdivisions may be recognized in the Lancaster drainage area. These subdivisions, occurring as belts trending northeast, or approximately at right angles to the major axis of the drainage area, are as follows:

(1) The northwestern section, making up somewhat less than one-third of the area, which is underlain by metamorphosed rocks of the so-called "Carolina Slate Belt." The geologic age of these rocks, although still subject to dispute, is probably pre-Cambrian or lower Paleozoic. The predominate rock type is a sericite schist.

(2) The central section, making up about one-half of the area, is underlain principally by crystalline igneous rocks, probably allied to the so-called "Carboniferous" granites of the Carolinas. The predominate rock type is a syenite, but much granite is found.

(3) The southeastern section, making up about one-fifth of the area, is underlain principally by a thin capping of poorly consolidated sedimentary rocks, probably the Tuscaloosa formation of the upper Cretaceous. The rock type is a medium coarse, slightly indurated sandstone.

The belts, as defined above, are only approximations, inasmuch as (1) small areas of crystalline rocks occur in the slate zone, (2) both outliers of sandstone and inliers of slates occur in small amounts within the crystalline zone, and (3) one large granite mass is exposed in the sedimentary zone. Furthermore, basic dikes of Triassic age and quartz veins of undetermined age are present in the country rock in varying, but generally small amounts.

With the exception of the sandstone, the rocks of the area are deeply weathered, and have given rise to fairly fine-grained soils.

Soils.--In general the slates and the syenites weather to form fine-textured soils, generally silt loams, while the granites and sandstone form coarser grained soils, ranging from fine sandy loams to sands.

The complex assemblage of rock types has given rise to equally complex residual soil types. Detailed mapping of the soils had not been undertaken and they can therefore be discussed only in general terms. Soils of the Georgeville, Herndon, Goldston, Alamance, and Orange series are recognized in the northwestern section, with Georgeville and Alamance probably predominating. Soils of the central section are of the Cecil-Appling-Durham group, including mixed phases overlying the syenite, that are not readily classified. Norfolk sand predominates in the southeastern section. There is some evidence of slight thicknesses or admixtures of this typically Coastal Plain soil over the other soils in the upper portions of the drainage area.

Residual soils over the basic rocks are relatively unimportant in the area. The stream-laid soils of the wider valley bottoms might be classed as Congaree.

Topography and drainage.--The drainage area of Lancaster Reservoir constitutes part of a broad, maturely dissected plateau. The moderately broad watershed divides and interstream ridges are gently rolling, but tend to break rather sharply near the larger streams. Maximum relief in the area is about 100 feet.

Drainage is well developed, following a dendritic pattern. The major stream has a well-defined, fairly broad, flat-bottomed valley. In general the streams have fairly steep gradients, probably much in excess of the 15 feet per mile gradient of the channel through the lake basin.

Erosion conditions.--Moderate to severe sheet erosion and occasional gullying has occurred over the greater part of the drainage area. Occasional small areas have been totally destroyed by gullying. In general erosion is more severe in the northern part of the drainage area. Roadside banks and ditches, as well as borrow pits from which road ballast has been stripped, are poorly protected and are subject to extensive gullying and sheet erosion.

There is evidence that locally, improperly constructed and poorly spaced terracing of farm lands has aggravated rather than abated the erosion problem.

Land use.--Practically the whole of the drainage area has been cultivated to clean-tilled crops at some time in the two hundred-odd years of agriculture. At present about 30 percent of the area is covered with second-growth timber, 10 percent is pastured, and 60 percent is cultivated. Of the cultivated land, about 55 percent is planted to cotton, 35 to 40 percent to corn, and only 5 to 7 percent to small grains.

On the whole, the drainage area has been subjected to an unusually high degree of intensive cultivation. Contour tillage and terracing have been practiced here for a number of years, but most of the terraces are of inferior design.

Mean annual rainfall:

Records of the cooperative United States Weather Bureau station at Heath Springs, S. C., located approximately 8.5 miles southeast of the reservoir and just outside the drainage area, show the following average annual rainfall:

Period	Inches
1902-38	44.81
1925-38	43.45

During the life of the lake (1925-38), the annual rainfall has ranged from 29.02 to 67.90 inches. Maximum rainfall occurs during June, July, and August but is on the whole fairly well distributed throughout the year.

History of storage.

Since the reservoir was constructed adequate storage has been available to supply the city's needs. The average draft on the reservoir is approximately 200,000 gallons per day, ranging from 160,000 gallons per day during the winter months to 240,000 gallons per day during the summer season of maximum usage. Domestic consumption accounts for most of the water used, only a minor proportion being used industrially. During the period of record the reservoir was only once drawn down below crest level (2 feet below crest for one very short period).

Turbidity records have been kept only during the last two years at the filter basin. During this time the turbidity ranged from 14 to 1,200 parts per million by weight. The average turbidity was 142 parts per million.

METHOD OF SURVEY

Original capacity and sediment volume in the lower portion of Lancaster Reservoir (from the dam to range R15-R16) were determined by the range method of survey, and in the delta section by the contour method.[1]

From a carefully measured 490-foot base line extending across the crest of the dam a triangulation system of 8 points was established by planetable and telescopic alidade. Eight additional control points, extending to the head of backwater, were established by stadia traverse. The crest-level contour line was mapped by plane table and telescopic alidade at a scale of 200 feet to the inch.

[1] Eakin, H. M. Silting of Reservoirs. U. S. Dept. Agr. Tech Bul. 524, 1936. (Revised by C. B. Brown, 1939). See pp. 153-169.

Nine ranges were established across the reservoir in suitable positions for the measuring of silt thickness and water depths in the lower portion of the lake. Adequate control for contouring the original and present lake bottom in the delta section was obtained by 56 well-spaced measurements of water depth and sediment thickness. All range-ends, cut-in stations, base-line stations, and stations used for control in mapping the delta area were permanently marked by stamped iron pipe set in concrete. Direct measurements of sediment thickness were made with 6- and 10-foot sediment-sampling spuds.

The contact between the lake deposits and the underlying submerged basin materials was sharp and easily identified except in the delta section. Three main types of old soil prevail, namely, (1) a reddish-brown to yellow clay loam, limited to the submerged valley walls in the extreme lower basin; (2) a gray sandy loam, occurring on the wide, submerged flood plain throughout the lake; and (3) medium to coarse quartz granules and rock fragments, confined to the narrow submerged stream channel.

The clay loam of the valley walls is very compact and sticky, and contains practically no organic matter and only a very minor amount of sand or coarser material. The submerged flood-plain material, while generally a sandy loam, ranges texturally from a sandy clay loam to a silty sand. There is a distinct tendency of the coarser-textured phases to occur immediately adjacent to the submerged channel in natural levees of a pre-lake period. On the whole, these old flood-plain deposits are considerably darker in color and decidedly more compact than the lake sediment. None of the sand in the old flood-plain deposits is coarser than medium grain-size, generally varying from very fine to fine. These flood-plain materials occasionally show a high organic content and frequently have a definite darker horizon, rich in organic matter and rootlets near the upper surface.

Eight samples of lake sediment were taken from various parts of the lake. These samples were located at points specifically chosen to give a representative figure and were obtained with a 1 1/2-inch tubular sampler previously described.[2]

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[2] Connaughton, Mark P., and Hough, Jack L. Advance Report on the Sedimentation Survey of Burlington Reservoir, Burlington, North Carolina. U. S. Soil Conserv. Serv. SS-28, p. 12, December 1938. (Mimeographed.)

SEDIMENT DEPOSITS

Character of Sediment

The sediment in Lancaster Reservoir ranges in texture from clay near the dam to coarse sand in the ponded-channel section. In the extreme lower section of the reservoir the sediment resembles a pipe-clay. On range R15-R16, the sediment is a fairly coarse silt with a minor content of sand. Within the delta section all textural variations occur from a coarse, washed sand in the channel to a fine silt near the outer shores. Sediment in the ponded-channel section is a coarse, washed sand.

Wave erosion in the wider parts of the lower basin section has resulted in a narrow, peripheral zone of sediment accumulation adjacent to the shore just below crest level. These littoral deposits which are made up of sand and gravel, constitute only a very minor part of the total sediment.

The sediment varies in color from a light gun-metal gray in the lower basin, to dark gray in the delta section, and to a grayish brown in the ponded-channel section. The organic content of the sediment is very low in the ponded-channel section, fairly high in the delta section and low but variable in the lower basin. Organic debris consists mainly of leafy matter and the remains of swamp growth from the delta section. In the lower basin the presence of organic matter is indicated by localized zones of a deep black color. The sediment is on the whole poorly compacted except for shallow water deposits in the delta region which have been exposed during infrequent periods of draw-down.

The location, depth relations, and weight per cubic foot of the sediment samples collected are listed in table 3. The samples were generally taken at intermediate depths below the sediment surface and probably represent average sediment conditions. Volume weights of the fine-grained sediment samples 1 to 7 were based on moisture content and dry-weight determinations of a small representative quantity of each of the samples. From these values the porosity and weight per cubic foot were calculated by assuming the density of the solid sediment was equal to that of quartz (165 pounds per cubic foot). These determinations were made by Jack L. Hough.

The volume weight of sample 8, composed of medium coarse, well-sorted quartz sand, was based on mechanical analyses made by Richard G.

Grassy in the sediment laboratory of the Sedimentation Division at Greenville, S. C. From the median grain size of the sample and preliminary data on the relationship of median grain size to porosity of sediments as taken from unpublished laboratory data on file in the Sedimentation Division, the average volume of the sample was estimated to be 80.0 pounds per cubic foot.

Table 3.—Bottom sediment samples from Lancaster Reservoir.

Sample No.	Location	Water depth	Silt depth	Weight per cubic foot
		Feet	Feet	Pounds
1............	Range R1-R2, 200 feet from R1	11.7	1.5	53.6
2............	Range R11-R12, 130 feet from R11........	6.0	1.4	70.0
3............	Range R15-R16, 65 feet from R15........	5.0	5.2	70.2
4............	End of submerged deltaic bar. 100 feet upstream from R15....	1.2	3.+	78.9
5............	Delta area, 260 feet opposite station 503.	1.6	2.+	68.4
6............	Submerged channel, 130 feet opposite station 503.............	1.0	4.+	39.4
7............	Delta area, 60 feet downstream from station 504.............	1.5	1.5+	61.5
8............	Ponded channel, 300 feet downstream from station 505.....	3.0	2.+	[1] 80.0
Average total sediment	....	....	....	65.3

[1] Based on assumed porosity of 40 percent in place.

Mechanical analyses of the 8 sediment samples are given in table 4. Analyses of the silt-clay fractions were made by the pipette

method. With the exception of the channel sand of sample 8, the sand fraction, including all material coarser than 0.05 mm. in diameter, consists almost entirely of very fine to fine sand.

Table 4.--Mechanical composition of sediment samples

Sample No.	Sand (>0.05 mm.)	Silt (0.05 to 0.005 mm.)	Clay (<0.005 mm.)	Median diameter	Less than 20 microns (0.02 mm.)
	Percent	Percent	Percent	Mm.	Percent
1	0.9	22.3	76.8	0.0022	95.2
2	4.7	50.1	45.2	.0073	79.0
3	13.0	62.0	25.0	.0163	55.0
4	16.7	66.7	16.6	.0260	42.7
5	77.0	62.0	31.0	.0112	63.4
6	9.4	59.2	31.4	.0114	61.1
7	8.0	66.3	25.7	.0162	55.3
8	100.0	—	—	.600	—

As shown by the analyses, the principal constituents of the reservoir sediment in relative order of abundance are (1) silt, (2) clay, and (3) sand. A definite, although irregular decrease in grain size toward the dam is shown. There appears to be little or no correlation between the volume weights, as given in table 3, and the mechanical composition.

Distribution of Sediment

As shown in table 5 the delta section, representing only 11.6 percent of the original storage capacity, has accumulated 32.7 percent of the total sediment in the reservoirs. Loss of storage capacity in the delta section amounts to 60.7 percent as compared to a loss of only 16.4 percent in the lower basin.

Table 5 --Volumetric distribution of sediment in Lancaster Reservoir

Section	Storage capacity			Sediment	
	Original	Relation to total original capacity	Loss	Volume	Relation to total sediment in reservoir
	Acre-feet	Percent	Percent	Acre-feet	Percent
Lower basin (dam to range R15-R16)	214	88.4	16.4	35	67.3
Delta (range R15-R16 to end)	28	11.6	60.7	17	32.7
Total Reservoir	242	100.0	21.5	52	100.0

Figure 5, showing original cross-sectional area and sediment area on ranges crossing the main stream, depicts graphically the longitudinal variation in sedimentation and its relationship to storage capacity.

Since the cross-sectional area of sediment is a function of sediment thicknesses and lake widths, the average thickness of sediment and the width of the lake on each range area are also shown graphically so that the relative importance of each may be noted. Figure 5 indicates that (1) the proportionate reduction in original cross-sectional area is greatest in the delta reach; (2) the average sediment thickness is fairly constant at about 1 1/2 feet in the lower basin, increases somewhat abruptly to 3 feet at the delta front, and thence decreases gradually toward the head of the backwater; and (3) variations in cross-sectional area of sediment in the lower basin reach are in accord with variations in lake width, whereas those in the delta are in accord with variations in sediment thickness, rather than lake dimensions.

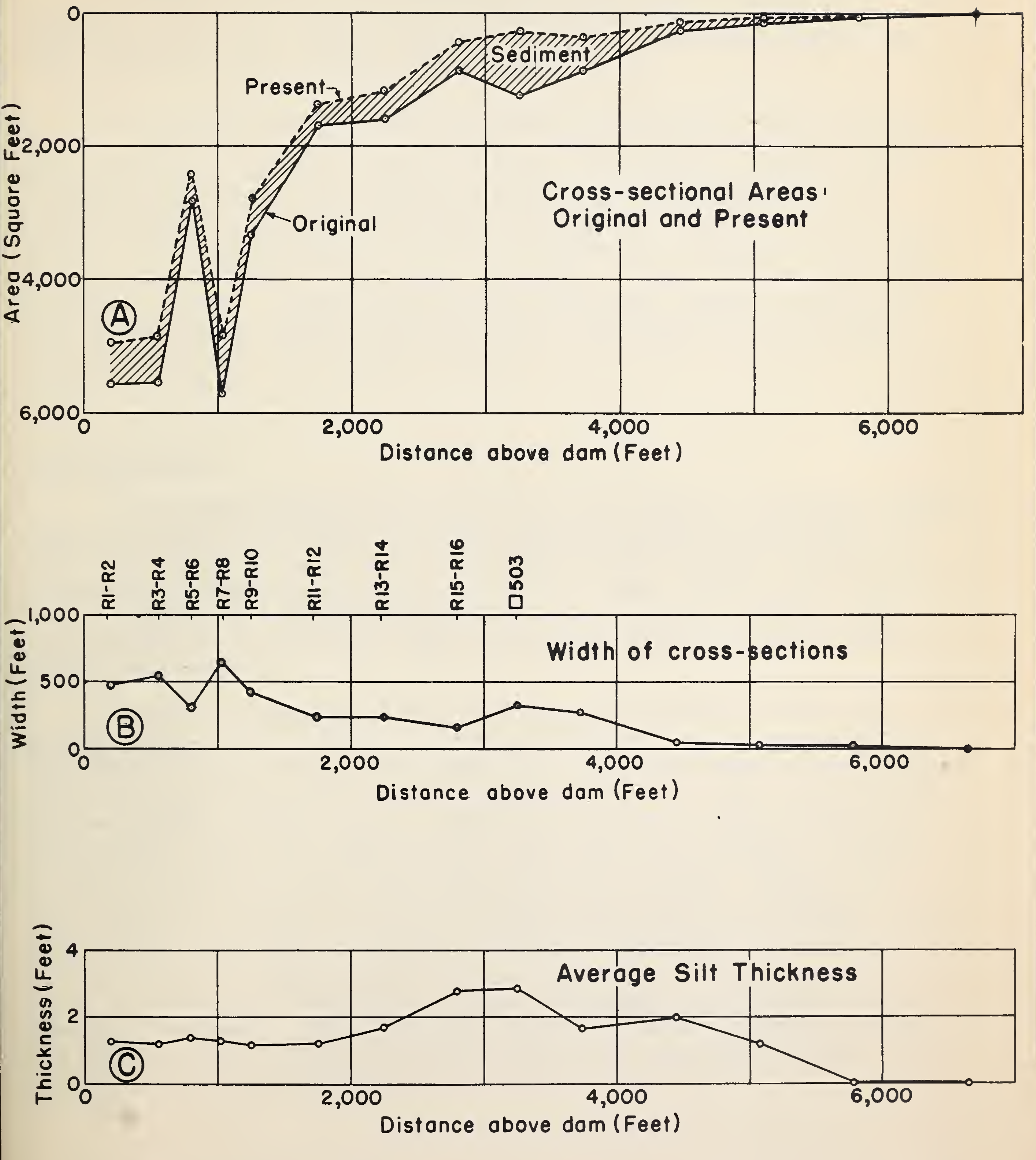


Figure 5: Distribution of sediment in Lancaster Reservoir, Lancaster, S.C.

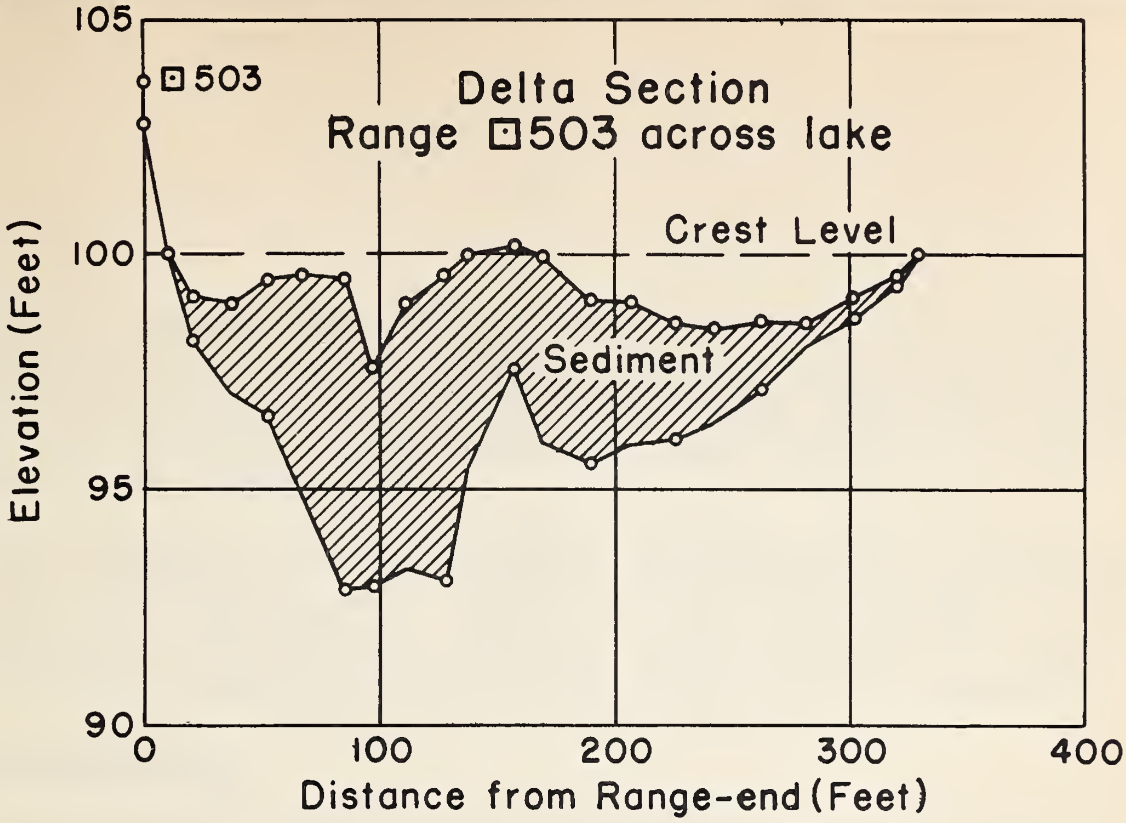
Maximum sediment thicknesses range from 5 to 6 feet in the delta reach and from 3 to 4 feet in the lower basin. Sediment thicknesses thus vary more with relation to distance below heads of backwater than with differences in original water depth.

The lateral distribution of sediment in the two major sections of the reservoir is illustrated by the cross sections shown in figure 6. These show that the delta region is featured by thick sediment in the original channel, by well-developed natural levees adjacent to the channel, and by decreasing thicknesses shoreward. These natural levees, while on the whole broader and of more gentle slope than the pre-lake levees, are analogous to the type of natural levees found on overloaded alluvial streams. In the lower basin region the sediment thicknesses vary laterally in general accord with the variations in water depth, although even here some slight tendency toward very flat natural levees can be discerned.

Delta Features.

The rather complex delta area is, on the whole, decidedly swampy, with the completely filled sections rarely attaining an elevation of more than 0.3 foot above lake level except in the natural levees where occasional hillocks rise to 1.5 feet above crest. By far the largest part of the area, both above and below water level, is covered with a dense growth of low-growing swamp vegetation, mainly cattails, marsh-grass, and sedge.

Figure 7, showing original and present contours in the delta region, brings out several interesting features. It is evident from the natural levees shown on the 1925 maps that this reach of the valley had been aggrading prior to the construction of the dam. Measurements of the original stream profile within the reservoir basin, as well as observations upstream, indicate that the delta now occupies a valley reach of exceptionally low gradient, where even under natural stream conditions sedimentation would be an important factor. Drainage of the flood plain behind the natural levees would have been impeded, and consequently semi-swamp conditions formed. Inundating such a reach of stream to only a slight depth of water naturally resulted in accelerating the rate of sedimentation without changing the essential distribution of sediment. Thus the delta area has received deposits rather uniformly and the original natural levees have continued to grow downstream as well as outward from the channel.



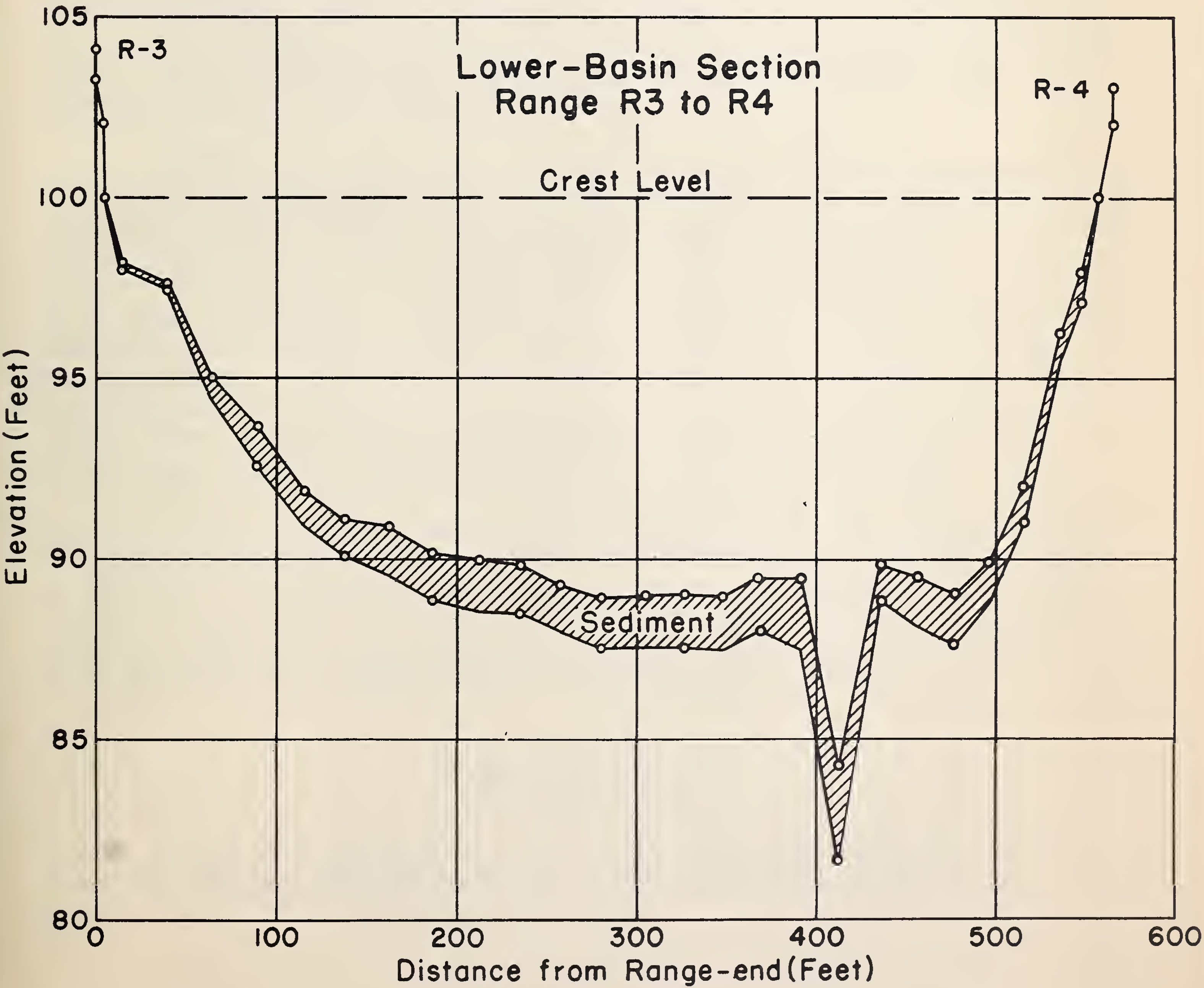


Figure 6: Representative Cross Sections of Lancaster Reservoir, Lancaster, S.C.

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Almost complete local plugging of the main stream channel has occurred near the end of the above-crest section of the natural levee. In the future this channel plug probably will tend to divert sediment-laden inflows off the sides and induce greater off-channel deposition in the delta reach.

Much sediment is being deposited overbank in the ponded-channel reach above the delta proper. This is due in large measure to the dense growth of brush (willows, elders, briers, etc.) which tends to impede the flow of floodwaters and induce deposition of sediment.

Mode of distribution.

It is evident both from the character of the sediment and its distribution through the reservoir that the dominant agent of distribution is current action caused by inflow. Progressive diminution of current velocity through the basin is reflected in the decreasing grain size of the sediment toward the dam. The wide extent of the delta area would seem to indicate that fairly coarse-textured material forms an important part of the normal stream load.

Neither wave action nor mass movement of sediment is believed to have any significant effect in this reservoir. The action of density currents or "underflows" (the process by which stream waters of a relatively high density, caused generally by the sediment content, tend to burrow under or flow beneath lake water of lower density) may, however, be of some importance. A well-defined occurrence of such an underflow phenomenon was observed in the reservoir during the period of survey. The phenomenon occurred near the mouth of the delta on June 18, 1938 following heavy rains on the night of June 17. The turbid inflowing waters, with a temperature considerably lower than that of the lake water, were observed to sink beneath the clear surface waters. The line of underflow was over the original channel and was convex downstream. This particular occurrence of underflow was not detected until the flood crest had passed, so that no measurements or estimates could be made as to the distance of travel of this underflowing mass. Study of the measured cross sections in the lower basin indicates a slight tendency toward the type of deeply submerged natural levees which may be anticipated in reservoirs where underflow does occur.

Origin of Sediment

The greater proportion of the sediment deposited in Lancaster Reservoir undoubtedly originates on clean cultivated lands of the

drainage area. A smaller but possibly significant amount originates in poorly protected road cuts. Stream-bank erosion and wave erosion of the shore line are not believed to be quantitatively important.

It is believed that most of the material in the fine-grained bottom-set deposits of the lower basin originate in the lower portion of the drainage basin, and are predominantly from the slate area, but also to some extent from the syenite. The sands of the delta area appear, in the main, to represent debris from the sandstone area with possibly some contribution from the granites.

CONCLUSIONS AND RECOMMENDATIONS

A summary of the data of the survey is given in the tabulation on page 18. The rapid storage loss of 1.6 percent per year when considered in relation to the normally expected increase in population and water demand, indicates the present need for constructive planning to assure an adequate supply of water in the future. Although it is evident that this need could be met to some extent by increasing the dam height, or possibly by constructing a silting basin upstream from the present reservoir, such measures can be looked upon only as temporary because they are subject to the same type of impairment by sediment as the present system. A permanently successful remedy should be sought, on the other hand, through prevention of sediment production at its source.

It has been pointed out that the larger part of the harmful sediment is derived from cultivated areas as a result of improper agricultural practices. That the use of approved soil conservation measures on these agricultural areas is capable of materially reducing the volume of sediment delivered to streams has been demonstrated in other areas. The need for a comprehensive program of such conservation measures, participated in by the city, the landowners, and the local Soil Conservation unit, is urgent. Such a program, properly carried out, would unquestionably pay for itself in terms of better and more permanent agriculture in the area and in a greater degree of protection for the city's investment in water supply.

It is recommended that steps be taken for active cooperation between city officials and the supervisors of the Soil Conservation Service District looking towards a unified attack on the problem of excessive sediment production in the drainage area as a whole. Such

a program must of necessity be based on detailed investigations and mapping of the area, with particular emphasis being placed on quantitative determination of the several sources and source areas of sediment.

Summary of data on Lancaster Reservoir, Lancaster, S. C.

	Quantity	Unit
Age [1]	13.4	Years
Watershed area [2]	9.4	Sq. miles
Reservoir:		
Area at spillway stage:		
Original	36.4	Acres
At date of survey	35.1	Acres
Storage capacity to spillway level:		
Original	242	Acre-feet
At date of survey	190	Acre-feet
Capacity per sq. mile of drainage area:[2]		
Original	25.74	Acre-feet
At date of survey	20.21	Acre-feet
Sedimentation:		
Total sediment	52	Acre-feet
Average annual accumulation:		
From entire drainage area	3.9	Acre-feet
Per 100 sq. miles of drainage area[3]	41.7	Acre-feet
Per acre of drainage area:[3]		
By volume	28.27	Cubic feet
By weight[4]	.92	Ton
Depletion of storage:		
Loss of original capacity:		
Per year	1.60	Percent
To date of survey	21.49	Percent

[1]Storage began in February 1925; date of survey June 15-30, 1938.

[2]Includes area of lake.

[3]Excludes area of lake.

[4] Based on a volume weight of 65.3 pounds per cubic foot as determined from the laboratory study of 8 representative samples.


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H.H. BENNETT, CHIEF
LANCASTER MUNICIPAL RESERVOIR
LANCASTER COUNTY
SOUTH CAROLINA
SEDIMENTATION SURVEY OF JUNE 15, 1938 TO JUNE 30, 1938
100 0 100 200 300 400 500
Scale in Feet
LEGEND
1001 △ TRIANGULATION STATION
501 □ INSTRUMENT STATION
R1—R2 SILT RANGE
ORIGINAL CREST CONTOUR
PRESENT CREST CONTOUR - (Where it diverges from original.)
SILTED AREA ABOVE CREST
Spillway
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
1001
1002
1003
1004
1005
1006
1007
1008
501
502
503
504
505
506
507
508
DAM
1
2
3
4
5
6
7
8
9
Turkey
Quarter
Creek
Original
Original
Original
Present
Original and Present
Contoured Delta Area above R15 - R16
M.N.